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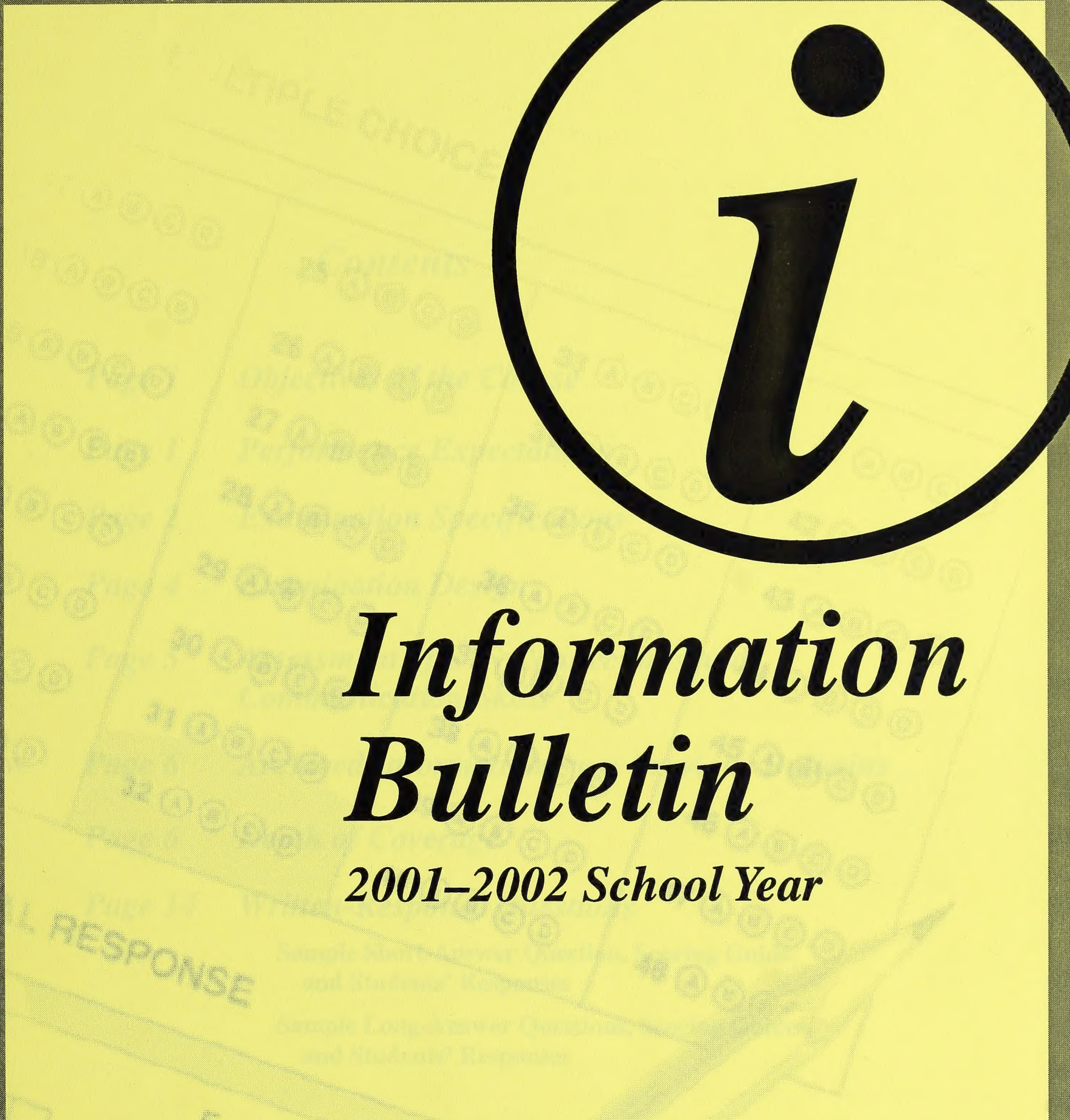
Science 30



Information Bulletin

2001–2002 School Year

Diploma Examinations Program

Alberta
LEARNING

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Sample Short-Answer Question, Scoring Guide, and Students' Responses

Sample Long-Answer Questions, Scoring Guides, and Students' Responses

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Objectives of the Course

Science 30 is intended for students who want to enhance their understanding of the scientific principles behind the natural events that they experience and the technology that they use in their daily lives. Science 30 is an inquiry-based course requiring creativity and imagination. The course is designed to provide students with a higher level of scientific literacy and to prepare them for post-secondary studies.

Students of Science 30 have developed their aptitude for observing, collecting facts, forming generalizations, hypothesizing, and making inferences from observations. They have shown growth in their understanding of scientific concepts by their ability to apply these concepts to relevant situations. They have developed a global view of the sciences and an awareness of the connections among them.

Experience in science courses, particularly Science 10 and Science 20, enables students to develop the required knowledge, skills, and attitudes that are prerequisites for success in Science 30.

Curriculum Standards

Provincial standards help to communicate how well students need to perform to be judged as having achieved the learnings specified for Science 30. According to the *Science 30 Program of Studies*, student learnings refer to specific knowledge, skill, and attitude expectations. These learnings are amplified in the Depth of Coverage section beginning on page 6 of this bulletin. These specific statements of standards are written primarily to inform Science 30 teachers about the extent to which students must know the Science 30 content and must demonstrate the required skills to pass the examination.

Performance Expectations

Acceptable Standard

Students who achieve the *acceptable standard* in Science 30 will receive a final course mark of 50% or higher. These students can state or solve single-step problems; as well, they are able to correctly answer questions involving concepts from a specified area of science. These students are able to follow correct laboratory procedures when given specific directions. They can make the connection between science concepts and laboratory activities when the data are used to verify known information. Drawing a graph from experimental data or reading values from a graph does not present a problem for these students. They use their scientific knowledge to explain the operation of various technologies studied in Science 30. Finally, they are able to present arguments about societal issues such as environmental and ethical concerns related to Science 30 content.

Standard of Excellence

Students who achieve the *standard of excellence* in Science 30 receive a final course mark of 80% or higher. They have demonstrated their knowledge, ability, and literacy in a broad range of science areas. Such students can integrate concepts from many areas of science. They demonstrate creativity and flexibility to solve multistep problems. They are able to design or refine laboratory procedures to demonstrate scientific principles or solve scientific problems. They can critically analyze scientific studies, including associated charts, graphs, and conclusions. These students are aware of the variety of viewpoints related to both the environmental and to ethical issues in the field of science and technology. They are able to clearly express their opinions about these issues.

Examination Specifications

Each Science 30 diploma examination is designed to reflect the Science 30 course general learner expectations (GLEs) outlined in the *Science 20–30 Program of Studies, Interim 1995.* The general learner expectations are expressed in more detail by the specific learner expectations (SLEs), which are organized into four units. Some questions on each diploma examination will assess achievement of specific learner expectations. Some questions will be based on the integration of the specific learner expectations.

All examination questions are organized into sets that relate to broad contexts. Therefore, a set of questions may assess a student's ability to integrate several GLEs. All questions will measure achievement of scientific knowledge; some will also measure achievement of skills and/or STS connections.

Each examination is built as closely as possible to these specifications. Small adjustments in emphasis may be necessary because the examination includes multimark written-response questions and/or machine-scored questions that cover more than one concept area. The concept areas are distributed proportionately over the examination. Questions that require knowledge and skill in applying scientific processes are distributed throughout the examination but are not associated directly with specific topics; this is also true of the STS connections.

The 2001–2002 Science 30 diploma examinations are constructed to place the following approximate emphases on the Science 30 general learner expectations.

Knowledge	***Emphasis***
The student can	
• show how the body maintains equilibrium with its environment through the interaction of the nervous, circulatory, and immune systems (Unit 1, Major Concepts 1 to 3)	15–20%
• show the role of DNA in maintaining equilibrium (Unit 1, Major Concept 4)	5–10%
• classify and describe systems (categories) of matter including acids, bases, and organic compounds based on their chemical characteristics and their impact on the environment (Unit 2, Major Concepts 1 to 3)	20–25%
• demonstrate a knowledge of the diversity (similarities and differences) in the properties of gravitational, electrical, and magnetic fields (Unit 3, Major Concepts 1 and 2)	10–15%
• demonstrate an understanding of the properties of the electromagnetic spectrum (energy), including the use of these properties in studying the history and structure of the universe (Unit 3, Major Concepts 3 and 4)	10–15%
• demonstrate an understanding of the sources of usable energy and the environmental impacts of various systems (forms) of energy production and use (Unit 4, Major Concepts 1 to 4)	20–25%

Scientific Process and Communication Skills	***Emphasis***
The student can	20–30%

- design, interpret, explain, analyze, and evaluate investigations
- organize data into tables, graphs, and diagrams and predict relationships
- interpret, explain, analyze, and evaluate data to infer relationships
- use appropriate scientific terminology and mathematical language to communicate and explain scientific concepts

Science, Technology, and Society Connections (STS)	***Emphasis***
The student can	20–30%

- apply cause-and-effect reasoning to formulate relationships in which scientific evidence shapes or refutes a theory, and explain the limitations of science and technology in answering all questions and solving all problems
- describe and evaluate the design and function of technological solutions to practical problems by using scientific principles and theories, and relate the ways in which science and technology advance one another
- evaluate from a variety of perspectives how science and technology are influenced and supported by society, and assess the ability of society to interact responsibly with the environment
- apply the skills and knowledge acquired in Science 30 to everyday life and to both related and new concepts in post-secondary studies

Examination Design

The design of the 2001–2002 Science 30 diploma examinations is as follows:

Question Format	*Number of Questions*	*Percent Emphasis*
Multiple Choice	40	50
Numerical Response	12	15
Short Answer	1	5
Long Answer	2	30

The machine-scored portion of each examination contains both multiple-choice and numerical-response questions, some of which may be linked.

Answers for multiple-choice questions are recorded in the first section of the machine-scored answer sheet. Answers for numerical-response questions are recorded in the second section on the same side of the machine-scored answer sheet. Answers to the short- and long-answer questions are written in the examination booklet.

Multiple-choice questions are of two types: *discrete* and *context-dependent*. A discrete question stands on its own without any additional directions or information. It may take the form of a question or an incomplete statement. A context-dependent question provides information separate from the question stem. Most of the multiple-choice questions are *context-dependent.*

A particular context may be used for more than one multiple-choice question as well as for one or more numerical-response questions.

Numerical-response questions are of three types: calculation of numerical values; selection of numbered events, structures, or functions from a diagram/list; and determination of a sequence of events.

The **written-response** portion of the Science 30 diploma examination consists of two types of questions: short answer and long answer.

The short-answer question has a raw score of 4 marks. The inclusion of a short-answer item allows us to ask questions that are narrower in scope than the long-answer items. This item requires the students to provide short explanations, show their work in a computation, or draw diagrams to demonstrate their understanding of a concept. The following are examples of short-answer items.

1. The balanced equation for the oxidation of glucose in the body is

$$C_6H_{12}O_{6(aq)} + 6\,O_{2(g)} \rightarrow 6\,CO_{2(g)} + 6\,H_2O_{(l)}$$

How much energy will be released by this reaction if one mole of glucose is oxidized? Show all your work.

2. Draw a circuit that shows two 12 V batteries connected in series to two light bulbs connected in parallel. Also include a voltmeter and ammeter in your circuit.

The long-answer portion of the Science 30 Diploma Examination contains two contextual questions: one that is skill-based and one that is STS-based. These are both open-response questions and each has a value of 15%.

The skill-based question may present a synopsis of a research project. Pertinent data are provided in the form of graphs and/or tables. Another approach may be to have the student design a study that might be used to address a particular situation. This question requires students to demonstrate a variety of science process skills.

The STS-based question presents a problem that requires students to make connections between scientific concepts, technology, and/or social issues. An acceptable response will demonstrate good communication skills.

Scoring guides for the long-answer questions are provided on pages 12 and 13 of the data booklet. Scoring guides for specific questions (such as those on pages 14 and 17 of this document) are derived from these.

Assessment of STS Connections and Communication Skills

Examination questions measure the students' understanding of scientific concepts. Some questions also measure the students' development of the skills and thinking processes associated with scientific inquiry. Other questions have been designed to measure students' understanding of the interrelationships between science and technology and among science, technology, and society.

Communication skills are assessed most directly in the marker-scored questions. The long-answer questions are marked holistically and include criteria for assessing communication skills along with criteria for assessing science content.

The term *communication skills* includes those processes by which information is expressed using appropriate conventions. These conventions include:

- words, sentences, paragraphs
- graphs, diagrams, tables
- mathematical formulas, mathematical and chemical equations
- significant digits, units of measurement, unit conversion

Conventions that are considered appropriate for a particular response are subject- and question-specific.

Archived Information from Previous Bulletins

NEW

Each bulletin contains unique information of value to teachers, especially teachers new to the program. Information such as course clarifications, reminders and explanations, and definitions of terms that are relevant to the diploma examination program can be found in the *Archived Information* section of specific subject bulletins on the web site (http://www.learning.gov.ab.ca/). Only information that is applicable to current diploma examination programs has been archived.

Year	Topic
1994–95	Sample Examination, Scoring Criteria, and Sample Answers
	Standards with Examples and Scoring

Depth of Coverage

Some teachers have expressed concern about the amount of material that must be covered in the Science 30 course. Teachers who have taught the course state that once the depth of coverage is understood, they are successful in achieving full coverage of the program. The following recommendations address the depth of coverage of the 15 major concepts in the *Science 30 Program of Studies*. These recommendations were made by teacher committees working with members of the Curriculum Branch and the Learner Assessment Branch of Alberta Learning.

Added to these recommendations are examples of the types of questions that have proven difficult for students across the province but that may be tested in the future.

Unit 1, Major Concept 1

The structure and function of the circulatory system includes knowing the four chambers of the heart, where the valves are located, and how they work. Memorization of heart structures such as Purkinje fibres, SA node, and AV node is not necessary. A general understanding of the structure and function of the various types of blood vessels is required. The detailed naming of vessels as belonging to renal, hepatic, or mesenteric systems is not required. It is reasonable to expect students to know the pulmonary arteries and veins, aorta, vena cava, and coronary vessels. The pathway of the blood from the vena cava, through the heart, to the lungs, back to the heart, and out of the aorta should be included. The depth of coverage for the other concepts and skills in Major Concept 1 seems to be generally understood. Teachers agree that if they do not go beyond what is stated in the *Program of Studies*, Major Concept 1 can be completed within about six hours of class time.

Unit 1, Major Concept 2

The structure and function of the body's defence mechanisms include the role of the skin as the first step in the defence process. Function, rather than detailed structure, of the skin is intended. The function of the cellular and non-cellular components of our immune system should not be dealt with in greater detail than the main events that are listed in the *Program of Studies*. The development of immunity or the failure to develop immunity and the role of vaccines are important and current topics.

While relating well with a working knowledge of blood types, Major Concept 4 in Unit 1 (genetics) is considered optional. The depth of coverage for the other concepts and skills in Major Concept 2 seems to be generally understood. Teachers agree that if they do not go beyond what is stated in the *Program of Studies*, Major Concept 2 can be completed within about four hours of class time.

Unit 1, Major Concept 3

The structure and function of the nervous system include the organs of sight; however, memorization of the structures within these organs, such as sclera and fovea, is not necessary. It is reasonable to expect students to know the main features of the eye such as retina, cornea, iris, optic nerve, pupil, rods, and cones. In describing the CNS and PNS, a general description of both their structure and function is all that is required. The concept of negative feedback for the control of blood pressure ties this major concept to the section on circulation. Students should understand the significance of vasoconstriction and dilation, but the role of baroreceptors goes beyond the depth required by the *Program of Studies*.

Students should be able to describe the transmission of an impulse across a synapse in general terms; for example, they should be familiar with the concepts of polarization, all-or-none response, and the functioning of neurotransmitters. Coverage of the role of sodium and the generation of an action potential has been dropped from the *Program of Studies*. The depth of coverage for the other concepts and skills in Major Concept 3 seems to be generally understood. Teachers agree that if they do not go beyond what is stated in the *Program of Studies*, Major Concept 3 can be completed within about six hours of class time.

Unit 1, Major Concept 4

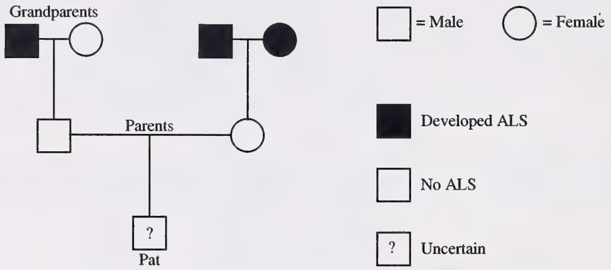
The principles of heredity should be explained using simple Mendelian monohybrid crosses and their probabilities. Students should be aware of dihybrid crosses, but they are not expected to calculate probabilities. It is reasonable to expect students to predict genotypic and phenotypic ratios that result from monohybrid crosses and to be able to use a pedigree chart.

Memorization of the steps of mitosis and meiosis is not necessary, but a general description of the sequence of events in these processes is required. For example, students should know that chromosomes double, line up at the equator, and separate and pull to opposite poles. The same depth should apply to gametogenesis and fertilization. Use of the biological terms for structure and function is not required, but it is reasonable to expect students to use the terms haploid and diploid in their descriptions. Students should be able to make the connection between fertilization and Mendelian crosses (Punnett squares). The general characteristics of DNA structure and function should be understood. Students are expected to know the base names and how they pair. A general description of the main events of replication (such as that the molecule unzips down the middle and new specific bases link) and protein synthesis is required, but the detailed naming of the steps in the processes (such as tRNA, ribosomes, mRNA, and codons) is not required. **Note: To help students understand the role of DNA in the body, Major Concept 4 mentions the importance of proteins. It is important for students to understand that proteins make up the structure of the cell and regulate the chemical reactions in the cell.** The depth of coverage for the other concepts and skills in Major Concept 4 seems to be generally understood. Teachers agree that if they do not go beyond what is stated in the *Program of Studies*, Major Concept 4 can be completed within about eight hours of class time.

Sample Question

Use the following information to answer the next question.

Pat's family has a history of ALS (Lou Gehrig's disease). The following is Pat's family tree.



1. The gene for Lou Gehrig's disease is

- ***A.** recessive
- **B.** dominant
- **C.** sex-linked
- **D.** nondisjunctive

Unit 2, Major Concept 1

Solutions may have to be reviewed at the beginning of this unit (three hours). Most of the acid-base concepts, such as classification, indicators, buffers, and titrations, are covered in simple Brønsted–Lowry principles (proton transfer). Students are not expected to determine the strength of an acid through the use of percentage of dissociation or through K_a or K_b calculations. Percentage dissociation has been removed from the data booklet. Titration calculations involving monoprotic acids should be kept simple and related to solution stoichiometry as much as possible. Students are not required to generate or interpret titration graphs. Students should be able to determine the ranges of pH from the colour change in indicators. The depth of coverage for the other concepts and skills in Major Concept 1 seems to be generally understood. Teachers agree that if they do not go beyond what is stated in the *Program of Studies*, Major Concept 1 can be completed within about nine hours of class time.

Students should be aware of the logarithmic nature of the pH scale.

Sample Question

2. The pH of some snow is 5.5 and changes to a pH of 7.5 when it enters a pond. The $[H_3O^+_{(aq)}]$ of the snow has

A. increased by a factor of 2
B. decreased by a factor of 2
C. increased by a factor of 100
***D.** decreased by a factor of 100

Unit 2, Major Concept 2

The major topic of this concept is the impact, from a local to a global level, of certain chemicals on our environment. The main sources and effects of listed pollutants should be understood. For example, over-fertilization of farmland leads to excess phosphates in lakes, which in turn leads to increased algal growth and the death of aquatic life. It is not necessary for the students to memorize a detailed series of chemical reactions to explain the cause and effect of certain air pollutants on our environment: simplified single-step chemical reaction equations are adequate. The depth of coverage for the other concepts and skills in Major Concept 2 seems to be generally understood. Teachers agree that if they do not go beyond what is stated in the *Program of Studies*, Major Concept 2 can be completed within about eight hours of class time.

Students are expected to understand the basic water-quality tests and the sampling protocols used in the tests.

Sample Question

3. An environmentalist expected a particular river's water to be high in organic content. High organic content in a river would result in

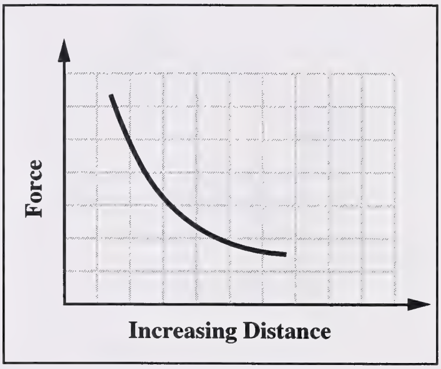
A. low BOD and clear water
B. high BOD and clear water
C. low BOD and cloudy water
***D.** high BOD and cloudy water

Unit 2, Major Concept 3

The organic chemistry nomenclature should be kept very simple and should focus more on identification of the compound by its functional group (see Science 30 Data Booklet) than on drawing and naming complex compounds. Structure, name, and use of the compound should be limited to the small, common members of each group. It is not necessary for students to learn chemical reactions or the structure of the organic compounds involved in the pulp and paper process. Pesticides should be covered in terms of the biomagnification aspect and their general characteristics, as is indicated in the second skill listed in the *Program of Studies*. Students should be familiar with chlorinated compounds such as dioxins, furans, CFCs, PCBs, and some pesticides. The depth of coverage for the other concepts and skills in Major Concept 3 seems to be generally understood. Teachers agree that if they do not go beyond what is stated in the *Program of Studies*, Major Concept 3 can be completed within about six hours of class time.

Unit 3, Major Concept 1

The emphasis of this major concept is on general principles. Problems should be straightforward and solvable in a single step. Students should understand that the strength of a field is inversely proportional to the square of the distance. One way for students to visualize this concept is graphically, as shown below.



This relationship can be compared with concepts such as half-lives and population growth. The depth of coverage for the other concepts and skills in Major Concept 1 seems to be generally understood. Teachers agree that if they do not go beyond what is stated in the *Program of Studies*, Major Concept 1 can be completed within about six hours of class time.

Students are expected to use the data booklet to help them solve single-step problems.

Sample Question

4. A space station orbited Earth at a distance of 4.2×10^7 m from the centre of Earth. The gravitational field strength at this distance is

A. 2.3×10^{-1} N/kg
B. 9.5×10^{-1} N/kg
***C.** 2.3×10^{5} N/kg
D. 9.5×10^{5} N/kg

Unit 3, Major Concept 2

In this major concept dealing with electrical technology, students must know how to use the data booklet at a "science-literate" level. Since there is not enough class time to practise all types and variations of questions, students must learn to determine what is required by the question, to identify what is given, and then to apply the appropriate formula.

Students may be required to solve simple two-step problems.

Sample Question

Numerical Response

1. A 100 W toaster and a 120 W frying pan are plugged into the same 110 V household circuit. If they are connected in parallel, how much current will they draw?
Answer: __2.00__ A.
(Record your **three-digit answer** in the numerical-response section on the answer sheet.)

Calculations involving circuits with complicated combinations of series and parallel formations are not required. The depth of coverage for the other concepts and skills in Major Concept 2 seems to be generally understood. Teachers agree that if they do not go beyond what is stated in the *Program of Studies*, Major Concept 2 can be completed within about nine hours of class time.

Unit 3, Major Concept 3

Memorization of the various types of EMR is not necessary. This information is in the data booklet. Qualitative descriptions (the fifth point in the *Program of Studies*) include demonstrating that EMR bends toward the normal when going from a substance with a lower index of refraction to one with a higher index of refraction. The greater the difference between the indices, the greater the amount of refraction. The application of trigonometry equations is not required. The depth of coverage for the other concepts and skills in Major Concept 3 seems to be generally understood. Teachers agree that if they do not go beyond what is stated in the *Program of Studies*, Major Concept 3 can be completed within about five hours of class time.

Sample Question

5. When Carol reaches for a stone that is located under water, the image of the stone is slightly displaced. This is because

- **A.** light from the stone is refracted toward the normal in air
- ***B.** light from the stone is refracted away from the normal in air
- **C.** polarized light from the water surface causes an apparent displacemen of the stone's position
- **D.** light from the stone is approaching the vertical angle for water to air, thus displacing the apparent position of the stone

Unit 3, Major Concept 4

The use of a spectroscope to analyze the composition of substances and the motion of stars is covered in this major concept, so a basic qualitative understanding of spectroscopy is necessary. A detailed knowledge of theories of the origin of the universe is not required. Students should know the basic principles of the Big Bang theory and how red shift provides evidence for this theory. Knowledge of the life cycle of stars (using the Hertzprung–Russell diagram) is not required. The depth of coverage for the other concepts and skills in Major Concept 4 seems to be generally understood. Teachers agree that if they do not go beyond what is stated in the *Program of Studies*, Major Concept 4 can be completed within about six hours of class time.

Unit 4, Major Concept 1

Some teachers indicated that they dedicate very little time to this major concept as a separate component. They prefer to integrate it into the other major concepts in this unit. This is a background topic for the unit, providing the "why" for further study. Interpreting data in graphical and numerical form as it pertains to energy consumption is important. Understanding exponential growth, sustainability, and the global distribution of energy use and production requires knowledge of half-life and doubling time. The study of energy sources must include assessing environmental impact of their development. This topic provides an excellent opportunity for risk and benefit analysis. The depth of coverage for the other concepts and skills in Major Concept 1 seems to be generally understood. Teachers agree that if they do not go beyond what is stated in the *Program of Studies*, Major Concept 1 can be completed within about four hours of class time.

Unit 4, Major Concept 2

Current energy sources originate from the Sun. This includes wind, hydro, and photosynthetic (fossil fuel) power. Life depends on solar energy through respiration of photosynthetic products. The following forms of energy conversions should be compared qualitatively: fuel combustion, solar-thermal, biomass, photoelectric, hydro, and wind. A clear understanding of energy transformations before its final use is necessary to discuss efficiency comparisons. Using Hess's Law to calculate the H_f of an unknown goes beyond the intent of the *Program of Studies*. However, students must be able to calculate the ΔH_r of a substance using Hess's Law. The depth of coverage for the other concepts and skills in Major

Concept 2 seems to be generally understood. Teachers agree that if they do not go beyond what is stated in the *Program of Studies*, Major Concept 2 can be completed within about seven hours of class time.

Sample Question

Numerical Response

2. $C_3H_{8(g)} + 5\,O_{2(g)} \rightarrow 3\,CO_{2(g)} + 4\,H_2O_{(g)}$.

The energy released when one mole of $C_3H_{8(g)}$ burns is 2044 kJ.

(Record your **four-digit answer** in the numerical-response section on the answer sheet.)

Unit 4 Major Concept 3

Both fission and fusion reactions produce energy according to the mass/energy equivalency. Students should be able to use the formula $\Delta E = \Delta mc^2$ to calculate the amount of energy available in nuclear reactions. Mass changes should be given in kilograms and energy in Joules so that a simple application of the formula is used without conversions. Students should be able to find missing nucleons in nuclear reactions and, given the reaction, predict the energy produced. Relative comparisons of the amount of energy involved in nuclear, chemical, and phase changes is expected. The depth of coverage for the other concepts and skills in Major Concept 3 seems to be generally understood. Teachers agree that if they do not go beyond what is stated in the *Program of Studies*, Major Concept 3 can be completed within about seven hours of class time.

Sample Question

Numerical Response

3. The total mass of the products in this equation is 3.10×10^{-28} kg less than that of the reactants. The amount of energy released by the reaction of each uranium atom is 2.79 $\times 10^{-11}$ J.

(Record your **three-digit answer** in the numerical-response section on the answer sheet.)

Unit 4, Major Concept 4

Gravitational fields can be a source of energy production through transformation of tidal energy. An understanding of tidal changes and the conditions necessary for transforming tidal energy is expected. The depth of coverage for the other concepts and skills in Major Concept 4 seems to be generally understood. Teachers agree that if they do not go beyond what is stated in the *Program of Studies*, Major Concept 4 can be completed within about two hours of class time.

Written-Response Questions

Sample Short-Answer Question, Scoring Guide, and Students' Responses

Each Science 30 diploma examination has one short-answer question. Students' answers are scored by teachers using a holistic scoring guide. The guide describes the characteristics of students' answers that correspond to one of five values: 4, 3, 2, 1, or 0.

The following section presents a short-answer question with examples of students' responses and the scoring guides that were used to score them.

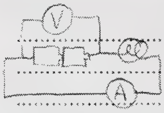
Short-Answer Question

Assume that you have been given a light bulb, a voltmeter, an ammeter, two 6 V batteries, and wire. Describe how to determine the resistance of the light bulb. Draw a diagram to show the circuit. Include the formula you would use to calculate the resistance of the light bulb.

Sample Scoring Guide for Short-Answer Question

Score	Criteria
4 *Standard of Excellence*	The drawing of the circuit is **clear, complete, and correct**. The explanation and the formula given to determine the resistance of the light bulb are **correct.**
3	The drawing of the circuit is **mostly correct but may have some details missing**. The explanation and the formula given to determine the resistance of the light bulb are **mostly correct.**
2 *Acceptable Standard*	The circuit drawn is a functioning circuit. The formula is **correct**, but the explanation is minimal.
1	The drawing of the circuit is **not clear**. The explanation and the formula given to determine the resistance of the light bulb are **incorrect.**
0	The response does not address any of the major points of the question at an **appropriate level** for a 30-level course.

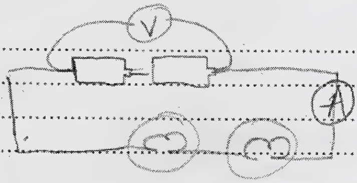
Sample Response 1



I would connect this circuit and then take the readings from the Volt-meter and the ammeter. Using the formula $R = \frac{V}{I}$ I could then calculate the resistance of the bulb.

Score—4
Rationale
The response includes the elements required to achieve the *standard of excellence*. The circuit is correct, showing the proper connections of the batteries, meters, and light bulb. The explanation and formula indicate the proper method to determine the resistance of the light bulb.

Sample Response 2



$R_t = R_1 + R_2 + R_3 + \ldots R_n$

Score—2
Rationale
This answer is an example of a response that meets the *acceptable standard*. The circuit is correct, showing the proper connections of batteries and meters; however, two bulbs are included in the circuit instead of one. Also, there is no explanation of how to determine the resistance of the bulbs. The formula relates to calculating resistances connected in series.

Sample Long-Answer Questions, Scoring Guides, and Students' Responses

Each Science 30 diploma examination has two long-answer questions. Both are open-response questions. Each student's answer is scored independently by two markers using holistic scoring guides. The guide describes the characteristics of students' answers that correspond to one of five values: 4, 3, 2, 1, or 0. The two scores are then added together for a total out of 8.

The sub-score out of 8 is then pro-rated out of 12. A summary of the calculations follows.

Marker 1 Score (X out of 4) + Marker 2 Score (X out of 4) = Sub-score (X out of 8)

Sub-score (X out of 8) × 1.5 = Pro-rated Raw Score (X out of 12)

If the scores obtained by the two independent markers vary by values of 2 or more, the scores are classified as *discrepant*. Responses that have *discrepant* scores are read by a third marker. The third marker must assign a score that equal to one of the scores of the first two markers or that is between these scores. This score will be multiplied by 2 for a total sub-score out of 8.

The following section presents two long-answer questions with examples of students' responses and the scoring guides that were used to score them.

Long-Answer Question 1

1. There are many ways to generate the electrical energy needed to satisfy the power needs of a country such as Canada. In every case, however, there are costs involved in the production of that electricity. For example, for every kilowatt-hour (kW•h) of electricity produced by using a new generation of gearless wind turbines, there is a cost of 7.5¢/kW•h. Coal-burning power plants may generate electricity at a cost of 6¢/kW•h. Photovoltaic cells can convert light energy into electrical energy at a cost of 40¢/kW•h.

a. Complete a data table to present the data given in the paragraph above.

b. Prepare a graph that displays the data about the costs of producing electrical energy using these three different technologies.

c. Some scientists suggest that the pollution costs of generating electrical energy by using coal as a fuel is at least an additional 3¢/kW•h. Compare the advantages and disadvantages of the use of coal-burning power plants with the use of wind generators. Include a detailed risk/benefit analysis. Describe the circumstances or conditions that would make the use of the wind generators feasible.

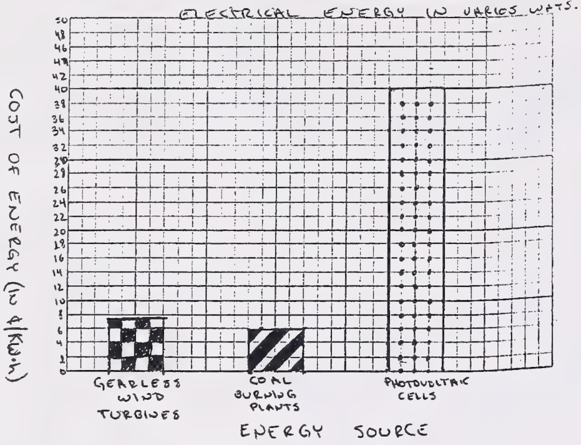
Score	Criteria
4 *Standard of Excellence*	The response is **well organized** and addresses **all** major points of the question. The student makes **effective** use of scientific vocabulary. The data are **accurately** and **completely** presented. The risks and benefits of each technology are **thoroughly evaluated**. The circumstances and conditions that would make the use of the renewable energy source feasible are **correct, well organized,** and **reflect a thorough understanding** and **logical consistency of thought**.
3	The response is **organized** and addresses **most** of the major points of the question. The student employs **correct** use of scientific vocabulary. The data are **completely** presented. The risks and benefits of each technology are **evaluated**. The circumstances and conditions that would make the use of the renewable energy source feasible are **organized** and **reflect a correct understanding**.
2 *Acceptable Standard*	The response addresses **most** major points. The student employs **inconsistent** use of scientific vocabulary, diagrams, and sketches. The data are **partially** presented. The risks and benefits of each technology are **listed**. The circumstances and conditions that would make the use of the renewable energy source feasible may be **disorganized** but the student demonstrates a **correct understanding**.
1	The response addresses **few** major points. The student **superficially** describes the concepts in sentences; as well, organizational skills, scientific vocabulary, diagrams, and sketches are **minimal**. The data are **incorrectly** presented. **Few** risks and benefits of each technology are **listed**. The circumstances and conditions that would make the use of the renewable energy source feasible are **disorganized** and demonstrate a **poor understanding**.
0	The response does not address any of the major points of the question at an **appropriate level** for a 30-level course.

Sample Response 1

Title: ENERGY COSTS FROM VARIOUS SOURCES.

SOURCE OF ENERGY PRODUCED	COST OF ENERGY (¢/KW·h)
GEARLESS WIND TURBINES	7.5¢/KW·h
COAL BURNING PLANTS	6.0¢/KW·h
PHOTOVOLTAIC CELLS	40¢/KW·h

Title: THE COST OF GENERATING ELECTRICAL ENERGY IN VARIES WAYS.



HUMANS HAVE YET TO FIND A SOURCE OF ENERGY THAT DOES NOT COME WITH IT'S SHARE OF DISADVANTAGES. THE MAIN SOURCE OF ENERGY CONSUMED ORIGINATES FROM COAL-BURNING-POWER PLANTS WHICH SUPPLY A VERY CHEAP SOURCE OF ENERGY. ALTHOUGH THESE PLANTS ARE CHEAP TO BUILD AND MAINTAIN THEY ALSO HAVE DOWNSIDES TO THEM. THESE DOWNFALL TO COAL-BURNING POWER PLANTS COMES FROM THE TONS AND TONS OF POLLUTION THEY SPEW OUT EVERY YEAR, THESE TOXINS ARE DESTROYING OZONE, CONTRIBUTING TO SMOG, HARMFUL TO WILDLIFE AND ALSO HARMFUL TO OUR SOIL AND WATER SUPPLY AS THEY CONTRIBUTE TO ACID RAIN. ONE OF THE OTHER RELATIVELY LOW-COST ENERGY SOURCES IS GENERATED BY THE USE OF WIND GENERATORS. IT WOULD COST 1.5 CENTS MORE PER KILOWATT PER HOUR, BUT SOME SCIENTISTS SUGGEST THAT THE POLLUTION COSTS OF USING

Score—4

Rationale

This response includes the elements required to achieve the *standard of excellence*. The table and graph are correct and complete. Although the student addresses some risks for coal-burning power plants, the response could have been improved by including reference to thermal pollution and particulates. The student demonstrated some sophistication in reasoning by recognizing the cost of changing over to wind power all at once. However, the idea of gradually introducing wind power that contributes to existing power grids could have been mentioned.

Sample Response 1 (Continued)

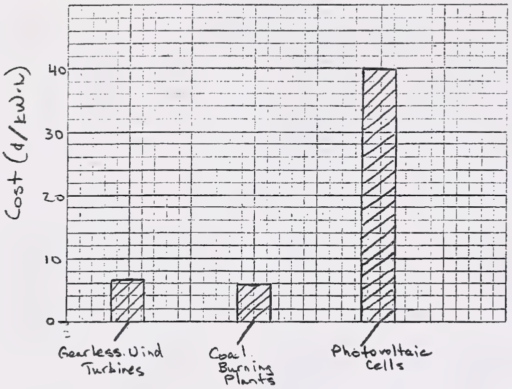
COAL AS A FEUL COULD AD UP TO AN ADDITIONAL 3 CENTS PER KILO WATT PER HOUR, WHICH WOULD REVERSE THE ADVANTAGE AND GIVE COAL A 1.5 CENT HIGHER COST PER KILO WATT PER HOUR. SO WHY DON'T WE JION GLOBALY AND SWITCH OUR ENERGY SOURCES FROM A NON-RENEWABLE, POLLUTION CREATING SOURCE, TO A RENEWABLE, CLEAN AND EFFECIENT SOURCE? BECAUSE OF THE PRESENT NUMBER OF COAL-BURNING POWER PLANTS THAT ARE IN OPERATION TODAY, IT WOULD COST BILLIONS OF DOLLARS TO CROSS OVER ALL AT ONCE, SO EVERY FEW YEARS A NEW WIND POWERED PLANT WILL BE CONSTRUCTED AND THE DEMAND FOR COAL-BURNING POWER PLANTS WILL SLOWLY DECREASE. ALSO THIRD WORLD COUNTRIES THAT DO NOT HAVE LAWS TO CONTROL POLLUTION WOULD NOT HAVE TO PAY THE ESTIMATED 3¢ MORE FOR CONTROL AS THEY ARE ON THE VERGE OF INDUSTRIALIZATION AND NEED THE CHEEPEST SOURCE OF ENERGY POSSABLE, POLLUTION OR NO POLLUTION.

Sample Response 2

Title: Cost of Electricity/kW·h

Type of Energy	Cost (¢/kW·h)
Gearless Wind turbines	7.5¢/kW·h
Coal burning plants	6¢/kW·h
Photovoltaic cells.	40¢/kW·h

Title: Cost/kW·h of 3 different Energy Sources



Wind power would be much cleaner but more expensive. More wind generators would be needed to produce the same amount of electricity that one coal plant produces. Coal plants are easily established in most parts of the world, but wind turbines would have to be strategically placed.

The risk of the continuous use of coal plants is the continued damage to our atmosphere. If the damage gets to severe the risk of a higher pollution cost is real as well. The benefit of wind turbines is easily seen but it is still a little impractical. In order for the turbines to be practical, a wider range of usable areas would have to be established.

The cost of turbines is not as high in total, because there would be no pollution costs.

Score—2

Rationale

This answer is an example of a response that meets the *acceptable standard*. The student has filled out the table properly. A bar graph is the appropriate format, and the scale is suitable for the data provided. The student recognizes that coal-burning power plants produce air pollution and that wind turbines are suitable in a limited number of areas. The cost of pollution is also recognized but is not used to make any recommendations. The response could have been improved by listing the types of pollution caused by coal-burning power plants. Also, a more detailed description of possible areas for wind turbines could have been included.

Long-Answer Question 2

2. Select a human disease or disorder. It may be viral, bacterial, or genetic, or it may be a disease that affects the circulatory or nervous system. Explain its mode of operation and how it affects the body. Describe the scientific and technological methods that are being used to treat and prevent the disease or disorder.

Score	Criteria
4 *Standard of Excellence*	The response is **well organized** and addresses **all** major points of the question. Descriptions and/or explanations of the disease or disorder, its treatment, and prevention are **correct, well organized, and reflect a thorough understanding and logical consistency of thought.** The student uses complete sentences that employ **effective** scientific vocabulary.
3	The response is **organized** and addresses **most** of the major points of the question. Descriptions and/or explanations of the disease or disorder, its treatment, and prevention are **organized and reflect a correct understanding**. The student uses complete sentences that employ **correct** scientific vocabulary.
2 *Acceptable Standard*	The response is **organized** and addresses **some** of the major points of the question. Descriptions and/or explanations of the disease or disorder, its treatment, and prevention are **generally correct** but **disorganized**. The student uses **complete sentences**, but the use of appropriate scientific vocabulary is **inconsistent**.
1	The response addresses a **few** major points of the question. Concepts are identified, but **interrelationships are not identified**. The student **superficially** describes the disease or disorder, its treatment, and prevention. Organizational skills and scientific vocabulary are **minimal**.
0	The response does not address any of the major points of the question at an appropriate level for a 30-level course.

Sample Response 1

Aids is caused by a virus that attacks the body's immune system. The virus is passed by the body fluids of one person entering another person. Unprotected sex and sharing needles are the most common ways that AIDS is passed along.

There are drugs that slow the disease down. AZT is one of these drugs. Scientists are trying to make a vaccine a gainst the virus, but the virus mutates so often that the body's antibodies don't recognize the new forms of the virus.

A person with AIDS usually dies from other infections because the cells of the immune system have been destroyed by the AIDS virus.

Score—4

Rationale

This answer represents a response at the *standard of excellence*. It is a very good summary of the cause and effect of AIDS. It could have been improved by the inclusion of a description of how the virus attacks T-cells and how it circumvents the immune system.

Sample Response 2

High blood pressure is a condition that a person who is overweight or unfit usually encounters. This is a circulatory problem that can be helped. High blood pressure is found when a person goes for a physical or just goes to visit the doctor. The doctor reads a persons blood pressure from an instrument that is in the office. Blood pressure numbers are read by saying the systolic number first then reading the diastolic number. An example of this would be saying a person has a blood pressure reading of 120 over 70, where the first number (systolic) should always be higher than the second. Blood pressure is effected by how much blood is passing through a persons veins and arteries each time the heart pumps. If a person had a good blood pressure, chances are that their arteries are able to move blood without any or little resistance. It is important to have good blood pressure so that the blood in your body can be continually filtered and "renewed" to keep your body healthy. There are many ways that a person can acquire high blood pressure. Family history would play an important role in decididing if you will have this disorder. High blood pressure can be reduced drastically by eating healthy, low fat foods and exercising regularly. The first piece of advice usually recommened by doctors to overweight, high-blood pressure patients is to do a little bit of exercise, like walking the dog more often. Since a persons diet is important in controlling blood pressure, many food companies have reduced fat content in much of the products that they sell.

It is important for a person to monitor their blood pressure and keep it at a "healthy" level to prevent their chance of getting a heart attack. In the greater scheme of things this is a fairly easy disorder to treat and to prevent!

Score—2

Rationale

This answer meets the *acceptable standard*. The response includes a description of how blood pressure is measured. The explanation of blood pressure is fairly accurate, but more details could have been included. Some means of preventing high blood pressure are presented. The response could have been improved by adding details about the damage high blood pressure can cause. Also, the drugs that are used to control high blood pressure could have been listed, along with their modes of operation.

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